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PROCEEDINGS
of the
ENTOMOLOGICAL SOCIETY *of* BRITISH COLUMBIA

Volume **39.** Issued October 10, 1942

PAGE

OBITUARY—A. A. Dennys; G. O. Day.

BONNELL & MOTE—Biology of the Klamath Midge, *Chironomus utahensis* (Diptera, Chironomidae) 3

HARDY—The Black Witch Moth *Erebus odora* (L.) in British Columbia 7

HARDY—Notes on Some Wood-Boring Beetles of Saanich, Vancouver Island, B.C. *(Coleoptera, Cerambycidae & Buprestidae)* 9

DOWNES & ANDISON—The Apple Sawfly *Hoplocampa testudinea* Klug. on Vancouver Island, British Columbia 13

HOY—The Advance of the Codling Moth in British Columbia 16

MARSHALL—Effect of Lime and Lime-Sulphur on the Larvicidal Value of Cryolite 19

SPENCER—A Note on *Laelius* Sp., a Parasite of the Carpet Beetle *Anthrenus scrophulariae* (L.) (Hymenoptera, Bethylidae) 21

SPENCER—Insects and Other Arthropods in Buildings in British Columbia 23

OLDS—The Results of Further Work Done on the Control of Grain Mites in British Columbia 29

GREGSON—Notes on the Laboratory Rearing of Some Canadian Ticks *(Acarina)* 32

Notes 22, 35

Change in Make-up. This is the first volume of our "Proceedings" to have a two-column printed page. The "Journal of Economic Entomology" uses a similar format, which is said to be less tiring to the eyes than the full-width page. Comments from members will be appreciated.

Volume *vs.* Number. Readers will notice that on the cover and title page, this copy is called "Volume 39". In the past each issue has been called a "Number", but as they are strictly speaking annual volumes, and as the word *number* is commonly used for one issue of a periodical, the above change is made.

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Arthur Alexander Dennys (1894-1942)

Alec Dennys was born on June 27, 1894, in Mussoorie, India, the son of Colonel and Mrs. W. Dennys. He was educated in England at Bedford Grammar School, St. Lawrence College, Dulwich College and Battersea Polytechnic, coming out to British Columbia in 1912 at the age of 17. He passed away in the Vancouver General Hospital on September 9, 1942, at the age of 48. He is survived by his wife and two sons, Kenneth W., in the Royal Canadian Air-Force, and Ronald G., at home; also by his father, three sisters and three brothers.

On coming to Canada he made his home near Salmon Arm. There he operated an apple orchard and was well known for his genial and kindly nature and for the help and advice he was always so ready to give in matters relating to fruit growing and the control of insect pests. The writer was privileged to know him since his arrival in 1912, and to have him on his staff in the Vernon Entomological office for 14 years.

Alec Dennys was interested in everything. He was an enthusiastic hunter and fisherman, a crack shot in spite of the fact that he lost the sight of his right eye at an early age, and an adept with a fly rod. He was a member of the Vernon Fish and Game Protective Association and for a time its secretary. He joined our Entomological Society in February, 1926.

Unselfish to a marked degree, he insisted on bearing more than his share of any work that there was to be done. On field trips he was always the first to cut the firewood, fetch water and do the many little tiring chores that befall the camper at the end of a weary day in the hills. For a number of years he had been interested in mining and geology, and many are the mining prospects in Southern British Columbia that at one time or another he had visited. But most of all Alec Dennys was interested in doing good work.

He was appointed to the Dominion Entomological Laboratory at Vernon in 1925, and served continuously until sickness forced him from his work in November, 1941. For sixteen years he travelled the fruit districts of the Interior of the Province working with growers at their spray machines, experimenting with new poisons, ever curious about anything that promised help in the war on insects. From his youth when he arrived at Salmon Arm from England, he worked in the orcharding business and at the time of his death still owned his original farm, "Westbourne". Perhaps it was this first-hand acquaintance that made him such an untiring enthusiast in attempting to solve the problems of the fruit grower.

Shortly after his appointment to the Dominion Entomological Branch he was sent to the East Kootenay district to work out the seasonal history and the best methods of control for the Colorado potato beetle, then a recently discovered immigrant to British Columbia. His energy and enthusiasm had such results that for years no new infestations were located. Later he accomplished the first detailed work on the biology and control of the apple mealy-bug in the Kootenay Valley. So thorough was this biological study that it has proved sufficient to guide all later control investigations. The apple woolly aphid was another insect that he studied very carefully. For its control he developed a canker paint that has been commonly and successfully used by fruit growers of the Interior.

Not often is a man so gifted with the power of concentrating on his work as was Alec Dennys. An example of that characteristic is the work that led to his discovery of a radical new procedure in controlling that worst enemy of the apple grower, the codling moth.

In 1939 he found by careful laboratory experiment that, contrary to what had been generally accepted, the codling moth adult could be killed by the use of a certain type of insecticide that it absorbs as it takes moisture from the surface of apple foliage. Laboratory research in 1940 confirmed his first results, so in 1941 he undertook to demonstrate by field experiment that his discovery was applicable to commercial practice. Week after week, Sundays and holidays, throughout the season he plunged into the investigation. He was far from well but he stuck to it until by October he had proved his point. A month later he left his desk and entered hospital. Even then he insisted on writing up and summarizing his data. This spring he published one of the most original contributions to the literature on the codling moth.

In addition to publications bearing on entomology, which are listed below, he often wrote short articles on natural history or hunting experiences, and gave several radio talks on entomological subjects over Station CKOV, Kelowna.

He was a photographer of unusual ability and handled all the photographic work at the Vernon Fruit Insects Laboratory. Among other devises he constructed a useful piece of apparatus for micro-photography.

In his passing the public has lost a fine servant and his host of friends and acquaintances a true friend.

E. R. Buckell.

Partial List of Articles by A. A. Dennys

1928. Some notes on the hibernating habits of insects in dry trees in the interior of B.C. Proc. Ent. Soc. British Columbia (1927), 24: 19-25, 1 text fig.

1933. Materials used as canker paints in woolly aphis control. Proc. Ent. Soc. British Columbia (1933), 30:8-10. (Abstract in Rev. Applied Ent. 22 (Ser. A, Pt. 2): 108).

1937. An orthopterous pest of apple trees in the interior of B.C. Proc. Ent. Soc. British Columbia (1936), 33:6-7, 1 text fig.

1938. Vigorous and varied tests being made as to new methods of combatting codling moth: interesting experiments at Vernon insectary. Country Life in British Columbia [Vernon, B.C.], 22(7): 20.

1942. Recent progress in codling moth control in British Columbia. II. Killing the adult. Scientific Agric. 22(10): 577-583.

Mr. G. O. Day, enthusiastic member and past President of our Society, died last spring. We have not yet been able to get the necessary information for a full obituary notice.

BIOLOGY OF THE KLAMATH MIDGE, CHIRONOMUS UTAHENSIS (Diptera, Chironomidae) *

D. E. Bonnell and D. C. Mote

Department of Entomology, Oregon State College, Corvallis, Oregon.

Introduction. During the past decade, midges have occurred in epizootic numbers in the Klamath Lakes area of Oregon and have occasioned annoyance and financial loss to the residents. The hordes of tiny winged insects, which superficially resemble mosquitoes, have upon many occasions been so great as to impede breathing and induce nausea in some persons. Tourist trade, summer residents, and resort owners were seriously disturbed. The radiators of travelling automobiles became clogged with the insects, causing the motors to overheat and the cars to stall. Cows became so irritated by the clouds of midges in the air and

* Published as Technical Paper No. 416 with the approval of the Director, Oregon Agricultural Experiment Station. Contribution of the Department of Entomology.

on pasturage, that they refused to eat, thus substantially reducing milk and butterfat production. Midges flew in such swarms at the big sawmills that their bodies were crushed in lumber during piling, and the resultant staining made resurfacing of the lumber necessary. An increase in the numbers of spiders and of blue-bottle flies followed midge concentrations.

Concurrent with the midges, vast masses of algae have appeared in Upper Klamath Lake. This suspended blue-green algae is filamentous in form *(Aphanizomenon)* and during the summer so dense as to give the water only a quasi-liquid appearance. These filaments may reach the number of 20,000,000 per cubic meter. The stench from decaying matter is often almost intolerable. Boating and swimming are impaired.

Chironomus utahensis is the most important of several species of midges in this area. Its breeding season and complete life history is, as yet, not fully known. Adult midges are common from June until cold weather in October. The true scope and enormous numbers of midge larvae on the bottoms of Upper Klamath Lake and Lake Ewauna, is best realized when compared with the numbers found by other investigators in the United States. Richardson (1928) reports more than 10,000 larvae, mostly *Chironomus plumosus*, per square yard in the Illinois River below Lake Pepira. Juday (1922) obtained an average of 2,000 larvae per square yard in Lake Mendota. Adamstone (1924) obtained an average of 293 larvae for all dredgings. Johnson (1930) reported an estimated average of 3,000 chiromid larvae per square yard in Lake Pepin. Compare these figures with Klamath's conservative minimum average of 1,000 larvae and ranging to a peak of 133,000, per square yard. Also conservatively estimated is the total population, at any given time during the summer months of the early 1930's, of over 500,000,000,000 larvae.

Description of the Area. Upper Klamath Lake, including its northward extension, Agency Lake, is one of the largest bodies of fresh water in the United States. It is roughly 35 miles in length from north to south, very irregular in outline, and varies from 2½ to 12 miles in width. Although it contains a few deeper areas of 8 to 13 meters, the bulk of the lake is very shallow and averages less than 3 meters in depth.

Sprague River, entering the Upper Lake at its north and east end, is the largest inflow. Several smaller streams and springs, notably Barclay Springs, Williamson River, and Crystal Creek, also enter the northern part. From Upper Klamath Lake, at an elevation of 4,141 feet above sea level, flows Link River, 1¼ miles in length, discharging into Lake Ewauna at an elevation of 4,080 feet. The Klamath River flows from Lake Ewauna through flat marshy country for 20 miles, to the town of Keno. There it breaks over a dam and begins its precipitous fall of 100 to 200 feet per mile on its way to the Pacific Ocean. The outflow of water from Upper Klamath Lake, via Link River, is checked by a dam. Power is used to service the industries and population of Klamath County. A portion of the water is diverted for irrigation purposes by the federal Bureau of Reclamation.

Geologically, the area is very old. The lake type is designated as eutrophic and is gradually filling up, with the area diminishing more slowly than the volume. The decreased depth has resulted in high water temperatures at all seasons except winter. The bottom, except for a few areas of shale, is largely diatomaceous ooze. The tule and lily beds and vast planktonic population of small plant and animal forms result in a rich organic deposit. The water is alkaline. The plankton population, and particularly algae, is so dense that secchi disc recordings are usually less than 1 meter during the late spring, summer and fall. Oxygen

and carbon-dioxide content varies exceedingly in different areas. Winds are prevailingly NW-N.

Biology of the Klamath Midge. Adult insects appear on wing in the late afternoon, early evening, and occasionally at dawn. A swarm starts with a few individuals, increasing in size as more enter; it is long, symmetrical, and top-shaped, and often composed largely of males. Swarms do not form during winds, and a gust of wind will drive one downward until the disturbance abates. A strong screaming hum is emitted and is often audible at a distance of more than a hundred yards. Occasionally a female will dart up from vegetation into the swarm. There she seizes a male by the thorax. They remain clasped for an instant and then drop downward, separating before contacting the ground. The male returns to the swarm. The female seeks concealment in vegetation and later deposits eggs on the water.

The eggs of *Chironomus utahensis* are light brown in colour, and measure about .09 mm. by .75 mm. They are embedded in a gelatinous mass that terminates in a thread with an attached disk for adhesion to some object floating in the water. Each mass contains from 1,000 to 2,000 eggs, and the masses vary in shape from a hollow "C" approximately 18 mm. long by 5 mm. in diameter, to a hollow sphere about 9 mm. in diameter.

The newly hatched larvae are transparent and about 2.5 mm. in length. In two or three days they begin to build body tubes, utilizing silk spun from glands in the mouth, and tiny bits of debris. The tubes are open at each end, larger in diameter than the body of the larvae, and are enlarged as growth requires. Undulation of the body sets up a current, providing an inflow of oxygenated water and food. As the larvae develop they respire by blood gills and become red in colour. The number of instars for *C. utahensis* has not yet been accurately determined but observations indicate 4 as in other species of chironomids. When the larvae have obtained their greatest size they are about 18 mm. long and 2 mm. in diameter. The larval stage usually extends for about 20 days, but may be much longer depending upon water temperature and possibly other factors.

Larvae apparently choose their food with care. One may anchor its caudal end just inside the tube by means of hooks on the end of its posterior legs, and feed over a circular area, the radius of which is determined by the larval reach. Midge larvae were brought into the laboratory. (1) Those in a little detritus and clear tap water showed distress. They built tubes but some, apparently unable to find food, deserted their habitations and ranged the bottom of the jars. The water was frequently replaced but no additional detritus was added. These larvae, without exceptions died within 3 days. (2) Others in a similar situation, but which had occasional detritus offered to them, survived for 5 days with the emergence of one adult female. (3) Larvae in 10 mm. of detritus and 300 cc. of lake water, which was not changed, lived from 5 to 13 days, but without emergence. (4) Those in frequently changed lake water but without detritus had two individuals survive 19 days. These larvae were divested of their tubes before immersion in the jars. They seized upon descending algae filaments and attempted to build tubes. The larger algae filaments were left undisturbed in the bottoms of the jars. Smaller filaments were apparently consumed. A microscopical examination of the alimentary tracts of some of these larvae revealed diatoms, desmids, fragments of minute crustacea, other bits of unidentifiable algae and, in one case, a live rotifer. Algae appears to be the predominant food, the crustacean fragments being, probably, ingested only incidentally.

Some larvae were divested of their tubes and placed in fresh well-oxygenated tap water. Water from Link River was strained through many thicknesses of fine-mesh silk cloth and 25 cc. added to each jar daily. The larvae apparently thrived, with some emergences. Possibly bacteria also, are an important item of diet. All laboratory rearing was done in semi-darkness under muslin.

An examination of several hundred larvae revealed them to be free of mites and nematodes.

Pupation takes place within the larval tubes. The pupal stage lasts three or four days. At the end of this period the pupae emerge and move about in the water by a jerking motion of their bodies, finally arising to the surface. After the pupal case breaks the surface film, oxygen is taken in, causing the pupae to glisten like silver. The pupal case splits dorsally along the thorax, the adult emerges, rests a moment on the floating cast pupal skin, then flies away.

The adult midge is approximately 12 mm. in length. The males are black, the females brownish gray. So far as is known at present, the adult midges do not feed. They are ephemeral and apparently do not live more than 4 or 5 days even under optimum conditions.

Midge adults, as a general rule, do not venture far from marginal vegetation. In light trap experiments, it was noticed that flying midges were taken in much smaller numbers in traps set away from the immediate vicinity of water than in those close to the water. Traps of the same type and light intensity that were set 200 yards from the water captured only 25% as many midges as the traps immediately adjacent to the water. Traps placed upon a bluff about 75 yards higher than the water and 100 yards distant from it, took even fewer midges, indicating that height above the water is also a limiting factor. On several occasions midge swarms were observed above the waters of Upper Klamath Lake more than 2 miles from the shore. Night flight range may be considerably shorter than day flight range.

Predators. The larvae are probably preyed upon by all 18 species of fish in Upper Klamath Lake. They form an important item in the diet of *Tigoma bicolor*, the Klamath chub, and *Siphateles b. bicolor*, the Klamath roach. The larvae are also food for aquatic beetles, larval dragonflies, and hemipterous nymphs, and also small marsh birds.

Adult midges are captured in considerable numbers by dragonflies, toads, small song birds, and spiders. Dragonflies, of the family Aeschnidae, are especially active during the periods of midge swarming, darting into swarms and seizing numbers of flies. Great numbers of toads, chiefly the western toad *(Bufo b. boreas)*, gather in the evenings near lights and capture adult midges. Examination of the stomach contents of 20 toads collected near light traps, revealed that each had consumed 10 cc. or several thousand midges. Spiders also consume quantities of midges and frequently become so numerous that they and their unsightly webs are a secondary problem.

Possibility of Control. Can an adequate control, either artificial or natural, be developed to decrease the numbers of the twin nuisances of algae and midges? Algae is apparently intimately associated with the midges and must be given consideration.

Much attention was given to light traps during 1939. Several of various sizes and designs were tested and those at the Bureau of Entomology Gnat Control at Clear Lake, California, were observed. While they capture an amazing number of insects, it is doubtful if present types would constitute a control measure. It is true that if sufficient labor could be employed, traps manufactured, and miles of electric wires strung, the midge nuisance might be abated, but the area could never be completely cleared

of midges, and discontinuance of the practice would allow reinfestation from adjacent waters. Light traps would be of value only to resorts and private residences.

A number of chemicals were tried, usually at the rate of one pound per 50 square yards of surface area, and then checked under field conditions. Some were applied on the surface to kill ascending pupae, and others, by tube sprayers, to the bottom to contact larvae. Midge larvae, in the experimental section of Lake Ewauna, were counted before and after application. A sub-surface apparatus was devised for preliminary chemical control.

Calcium arsenate, basic copper sulfate, Bordeaux, pyrethrum, and Paris-green all gave a fair degree of control ranging from 50 per cent to 98 per cent in different areas. Crushed salt, sown by hand gave a 100 per cent kill in the area examined. Phenothiazine and miscible oil destroyed great numbers of ascending pupae. Some of the chemicals approached laboratory expectations, particularly phenothiazine and crushed salt but at present no recommendations can be made.

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THE BLACK WITCH MOTH EREBUS ODORA (L.) IN BRITISH COLUMBIA

G. A. Hardy

Provincial Museum, Victoria, B.C.

Introduction. The capture of two specimens of this phalaenid moth in Victoria last season has led to inquiries regarding its occurrence in British Columbia. Authentic records have proved to be so few it is thought desirable to bring them together in this paper as a basis for future reference and investigation. Allusions to mysterious and elusive gigantic moths have been made from time to time; some of them may refer to the species in question, but lacking confirmation we suspect the Polyphemus or Cecropia moths, of the same size and well-known residents of British Columbia.

Description. The Black Witch, *Erebus odora*, was described by Linnaeus in 1758 as *Bombyx odora*, *Erebus* being assigned in 1810 by Latrelle. It early attracted the attention of naturalists, yet is sufficiently distinctive to have only one synonym, *agarista* Cramer, 1887. It is a large moth with wings extending over 6 inches and broad in proportion. The forewings suggest the clean-cut lines of a hawk; the nervures and membranes

are unusually tough, and capable of much hard service. The thorax is broad and very rigid. In fact this moth has an exceptional physique, suited to long journeys.

Distribution. The Black Witch is native to the West Indies, Central and South America, where it is common. In North America it ranges in the east through the Atlantic States from Florida to Canada and in the west from Mexico through California to British Columbia, becoming scarcer and later in the season the farther north it occurs.

The species had not been known to breed north of Mexico, until Dr. John A. Comstock published a beautifully illustrated description of larvae and pupae found in southern California. It is probable that our migrants come from there, or from adjacent Mexico. The food plants are cited as belonging to the *Leguminosae* specifically *Cassia fistula, Pithecolobrium* sp., *Saman* sp., *Gymnocladus dioica,* and in California, *Acacia decurrens.*

Habits. The little evidence obtainable suggests that the Black Witch is more of a chance wanderer than possessed of any definite migratory instinct. As is already intimated it is a powerful flier, and no doubt of a restless disposition. Its occurrence in British Columbia is due to an exceptional combination of favourable conditions; in 40 years there are only six authentic records. All of these are from points in southern British Columbia, with a majority from Vancouver Island. These captures appear to have been in towns or cities but this may be due either to attraction to lights, or the fact that they would not be as readily observed in country districts. The two taken last year in Victoria were at rest in dark buildings and only moved when disturbed, indicating they are normally night or dusk fliers. Their wings are much frayed at the edges, and the thorax of each is denuded, but the wing pattern is still distinct.

List of known specimens of *Erebus odora* taken in British Columbia:

The Provincial Museum, Victoria, B.C.

1. Female, Victoria, V. I., August 6, 1908. E. M. Anderson.
2. Female, Oak Bay, V. I., August 25, 1915. E. M. Anderson.
3. Male, Victoria, V.I., August 12, 1941. Dr. L. J. Thompson.
4. Male, Cadboro Bay, V. I., August 28, 1941. Allan Upward.

The University of British Columbia, Department of Zoology

5. Male, St. Leon Hot Springs, Kootenay Lake, B.C., August, 1905.
6. Female, "Unlabelled, possibly caught by F. K. Auden".

Canadian Records. A search through the literature has brought to light a number of Canadian records outside of British Columbia, over the same 40 year period. These may be summarized as follows: 26 specimens are known to have been recorded, their distribution by Provinces, east to west, being—[Newfoundland, 1]; New Brunswick, 2; Quebec, 4; Ontario, 3; Manitoba, 4; Saskatchewan, 2; Alberta, 3; and British Columbia, 8.

The sexes were about equally common. One specimen was captured in July, 11 in August, and 2 in September. Some examples were taken by "sugaring", others at lights, and the rest in dark buildings by day.

Acknowledgments—I wish to express my cordial thanks to Professor G. J. Spencer of the University of British Columbia for information regarding specimens in his department, and to Mr. J. F. Gates Clarke of the Bureau of Entomology, Washington, D.C., for the trouble he has taken in looking up references for me.

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NOTES ON SOME WOOD-BORING BEETLES OF SAANICH, VANCOUVER ISLAND, B. C. (Coleoptera, Cerambycidae & Buprestidae)

G. A. Hardy

Provincial Museum, Victoria, B.C.

Introduction. The incentive for this study was the discovery of a new road allowance through a tract of forest and bush land. The resultant tangle of stumps, logs and slash afforded an ideal attraction for Cerambycids and Buprestids intent on mating and ovipositing.

The area involved is about 3½ miles north of Victoria, B.C., at the edge of the southern slope of Mount Douglas, where it merges into low-lying flats and hollows. The trend of the road is east and west; it is about a quarter of a mile in length, a convenient size for detailed examination. On the east the road has its beginning at the base of a rocky slope supporting an extensive stand of Garry oak, *Quercus Garryana*. Continuing in a westerly direction the road passes through a shallow valley, crosses a low ridge, and descends again to damp bush and meadow land.

The central ridge supports a heavy stand of first and second growth Douglas fir, *Pseudotsuga taxifolia*, and grand fir, *Abies grandis*, with underbrush of ocean spray, *Spiraea discolor*, in the few open spaces. On the lower ground, alder, *Alnus rubra*, black poplar, *Populus trichocarpa* and aspen, *Populus tremuloides* are the dominant trees, with a luxuriant growth of moisture-loving shrubs of willows, *Salix* spp., crab-apple, *Pyrus diversifolia*, black hawthorn, *Crataegus brevispina*, dogwood, *Cornus pubescens*, cascara, *Rhamnus purshiana* and others.

It was hoped that with such a variety of newly-cut wood exposed at the right season, a large number of species of Cerambycidae and Buprestidae would be found. Accordingly the place was visited as often as possible during the season from March to September, 1934. Notes and collections were made at each visit.

Annotated List of Species. The following list includes all the species of wood-boring beetles collected or observed in this study, together with brief notes on their numbers, habits and dates of collection. Species occurring in numbers exceeding 50 individuals are marked "abundant", those between 25 and 50 are designated as "common" while those between 8 and 25 are noted as "several." When fewer than 8 were collected the exact number is given. All records are confined to the area outlined unless otherwise stated. The specimens mentioned in the list are in the Provincial Museum at Victoria, B.C. The arrangement followed is according to Leng's Catalogue (1920) but with the nomenclature revised in certain cases to agree with more recent taxonomic studies.

CERAMBYCIDAE

Prionus californicus Mots. One under a board at base of oak, July 25. A common species. The adults are nocturnal. The larvae feed in the roots of decayed Douglas fir, grand fir, oak, etc.; occasionally found in the underground portion of fence posts except those of cedar.

Megasemum aspera Lec. One, crawling over Douglas fir wood at 8 p.m., July 4. This is a nocturnal species and is often found in such odd places as water barrels, window ledges, etc., attracted to the vicinity by light. It has been found breeding in Douglas fir stumps.

Tetropium velutinum Lec. One, under a slab of Douglas fir bark, 5 p.m., June 22. Nocturnal, not common. Larvae in Douglas fir.

Opsimus quadrilineatus Mann. One, at rest on Douglas fir stump, 5 p.m., April 22. Another member of the night brigade. They have been found in the base of dead Douglas and grand fir trees 4 to 6 inches in diameter, where the larval stage is passed; the outer portion of the burrows provide winter quarters for the adult.

Leptalia macilenta (Mann). One, on flower of *Rosa nutkana*, June 3. I have never taken it under any other circumstances. Breeds in alder.

Leptalia macilenta v. frankenhauseri Mann. Three, on blossoms of *Rosa nutkana*, May 26. This is the commoner form here, distinguished by the pale lines at the base of the elytra, from the all black colour of *macilenta*.

Pidonia scripta (Lec). Several, on flowers of *Rosa nutkana*, May 13-26. Common, usually seen only on flowers where they feed on the pollen by day, hiding between the overlapping petals by night.

Toxotus vestitus Hald. Four, on flowers of *Rosa nutkana* and resting on trunk of grand fir. May 26-July 4; both the red, and black-legged forms. Has been reared from the decayed roots of Douglas fir.

Centrodera spurca (Lec). One, flying to artificial light at dusk, June 22. A nocturnal species. Adults have been dug out of the ground in the vicinity of Garry oak trees among the roots of *Rosa nutkana* in February. Large larvae were found in gall-like swellings at the base of the rose bush but as I was unsuccessful in rearing them, proof as to their identity is lacking.

Anoplodera vexatrix Mann. Several, on bloom of *Spiraea discolor*, June 24. This is their favourite flower, affording both food and protection as they like to push their way into the heart of the inflorescence.

Grammoptera filicornis Csy. Common, on flowers of *Rosa nutkana*, May 6 - 26. Mating pairs were found on freshly cut branches of *Populus trichocarpa* giving an indication of their host plant, but no further developments were observed as proof of this.

Leptura obliterata (Hald). Common, usually taken in flight and resting on or crawling over Douglas fir logs, July 1-29.

Anoplodera laeta Lec. Several, August 23, flying about freshly-exposed roots of recently-felled Garry oak, in which it breeds.

Anoplodera crassipes Lec. Three, at rest on leaves etc. One, on flower of *Carum Gardneri*. Breeds in *Abies grandis*, *Betula occidentalis*, etc.

Anoplodera dolorosa Lec. One, on flower of *Spiraea discolor*, July. It is commonly taken feeding in flowers of *Spiraea discolor*, and breeds in Douglas fir.

Anoplodera chrysocoma Kby. One, on flower of *Rosa nutkana*, May 13. A very wide ranging species recorded from coast to coast.

Anoplodera dehiscens Lec. One, flying about Douglas fir wood, August.

Ulochaetes leoninus Lec. Five, two males and three females, taken in flight June 10 and July 1 - August 26. Flying about logs of grand fir and walking over roots and stumps of same. One of our finest

longhorns. It resembles a bumblebee both in appearance and actions.

Necydalis cavipennis Lec. One, extracted from pupal cell in Garry oak stump in February. It is usually scarce, but may be seen in a small "colony" flying about an old oak stump, probably one brood emerging from that particular stump. It has a very close resemblance to an Ichneumon.

Rosalia funebris Mots. One, flying among Douglas fir stumps on which it alighted, no doubt having strayed from a nearby alder clump. July 29. Our most handsome species, typical of the Vancouveran fauna; found in numbers about alder logs in which the larvae feed. It can emit a faint rasping sound by rubbing the edge of the pronotum over a file-like process on the mesonotum.

Semanotus ligneus amplus Csy. Two, on cedar fence post, March 28. This is exclusively a cedar feeder in the larval stage. They may be taken in numbers in late winter by digging them out of their pupal cells in cedar logs a year old.

Semanotus litigiosus Csy. Six, two on Douglas fir slash, April 28, four about Douglas fir logs, April 26. They keep to the undersides of branches and are easily overlooked.

Gonocallus collaris Kby. One, at rest on Douglas fir slash, 5 p.m., June 17; no others found. First record for Vancouver Island (Hardy, 1936). Occurs across the continent in the north from Newfoundland to Alaska, south to British Columbia.

Callidium vancouverense V. D. Several on Douglas fir slash, April 28-30; they were busily running about on the underside of the branches, mating and ovipositing and occasionally flying.

This species originally described from specimens taken at Sidney, V.I., is closely allied to the western form of *C. antennatum* var. *hesperum*.

Phymatodes decussatus v. obliquus Csy. Several, Garry oak logs and slashing, June 24. Often found abundantly about dead oak trees.

Xylotrechus undulatus Say. Three, running over Douglas fir logs and on trunk of grand fir, June 10 and August 5.

Xylotrechus annosus (Say). One, flying and alighting on newly-felled *Populus trichocarpa*, April 22. The only two other known records for Vancouver Island are Sidney and Nanaimo. Breeds in *Populus*.

Neoclytus conjunctus (Lec). Several, Garry oak logs and slash, March 15-22. Nearly every dead or decaying oak tree is riddled with their borings, the smaller branches ofter being reduced to powder.

Monochamus obtusus Csy. One, grand fir log, July 29. This is the first record for Vancouver Island of this species. (Hardy, 1936).

Monochamus oregonensis Lec. Abundant, frequenting logs of grand fir, May 26-June 15. Flying about in the vicinity, or at rest on the sides or beneath the logs where they were noticeably in pairs.

Synaphoeta guexi (Lec). Seven, on willow logs, July 1 - August 5. This somewhat scarce species was found on the logs at the hottest time of the day. One female resting on the side of the log, was joined within five minutes by three males, no doubt arriving in response to a "wireless" call.

BUPRESTIDAE

Chrysophana placida (Lec). Seven specimens of this attractive little species were taken on newly-cut Douglas fir cordwood, June 10 and July 1. It breeds in various conifers, and the larvae sometimes mine the center of pine cones.

Chalcophora angulicollis (Lec.) Several specimens of this large species were taken. The heavy booming flight and clumsy hit or miss alightment gives a ludicrous note to the "seriousness" of collecting. May 13 - June 29.

Dicerca sexualis Cr. Eleven specimens, in flight or at rest on stumps and logs

of *Abies grandis*. Very unemotional and easily picked up though ready to feign death and drop to the ground. June 10 and July 1-29.

Buprestis aurulenta L. Common, in flight or at rest or ovipositing on logs of both Douglas fir and *Abies grandis*. May 13-July 4.

Buprestis rusticorum (Kby.) Very common, on *Abies grandis*, June 10-July 29. Sluggish and easily approached.

Melanophila drummondi (Kby.) Most abundant of all the Buprestidae. Chiefly on Douglas fir and *Abies grandis*. May 26 - August.

Melanophila acuminata (Deg.) Several, on *Abies grandis*. Very active both in running over the bark and in taking wing. May 26 and June 15. A northern species extending across the continent along the coniferous belt.

Anthaxia aeneogaster Lap.-Gory. One, on Douglas fir slash, March 22. This species is often found on the dandelion and other yellow flowers.

Chrysobothris pseudotsugae Van D. Four, on Douglas fir logs. Exceedingly active and taking to flight as readily as a fly. June 3 and July 1.

Chrysobothris femorata Oliv. Two, one on *Populus trichocarpa*, the other on *Pyrus*. June 10 and 20.

Summary and Conclusion. Of the seventy or so species of Cerambycidae known to occur on Vancouver Island, thirty-one or about 37 per cent, were captured in this restricted area. Two were first records for the Island.

The most noticeable fact brought out in a study of the list of Cerambycidae is that many of the species are represented by only one or two individuals during the entire season. This apparent scarcity could be accounted for by the fact that some are crepuscular or nocturnal in habit as for example *Prionus californicus* and *Centrodera spurca*. Other species such as *Pidonia scripta* and *Grammoptera filicornis* are generally found on flowers. *Monochamus oregonensis* was one of the few common beetles met with, and from its size and the known powers of the larvae to damage timber by their extensive tunnelling in the heartwood, it might be considered the most important species from an economic aspect.

Of the family Buprestidae, ten, or nearly 50 per cent of the twenty-two species known to occur on Vancouver Island, were collected. Three of these were very common. *Melanophila drummondi* was the most abundant, equalling in numbers the combined individuals of the Cerambycidae and Buprestidae. Members of the Buprestidae are essentially sun-lovers and perhaps for this reason they were met in greater numbers than were the Cerambycidae.

This preponderance of Buprestids might also be accounted for by the fact that except for one species, *Anthaxia aeneogaster*, the members of this family spend their whole existence in the vicinity of their host trees, while the Cerambycids wander considerable distances in search of flowers or are nocturnal in habit. For these reasons a census taken under the conditions outlined will naturally show that the majority of species are those which are most attracted to newly-felled trees.

Considering the two families with reference to their host trees, Douglas fir and grand fir were by far the most attractive, 20 species being observed on or about them. Garry oak came second with 5 species, black poplar 2, aspen and willow with 1 each. No species of either family was seen to pay attention to the stumps or slash of the other shrubs mentioned, although slight evidence of their larval work was noticed in crab-apple.

Acknowledgments—I am grateful for the help received from the late Ralph Hopping of Vernon, B.C., for verifying identifications and for other related matters, to Dr. E. C. Van Dyke of Berkeley, California, for similar services and to Mr. L. S. Dillon of the Reading Public Museum and Art Gallery, Reading, Pennsylvania, for critical examination of *Monochamus obtusus*.

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THE APPLE SAWFLY HOPLOCAMPA TESTUDINEA KLUG. ON VANCOUVER ISLAND, BRITISH COLUMBIA*

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In June 1940 some small apples damaged by a boring insect were brought to the Entomological Laboratory at Victoria by the owner of a city garden. Each apple had a round hole in the side nearly one-eighth of an inch in diameter; the interior was extensively excavated and contained a black oozy pulp. In some of the apples a whitish sawfly larva was found. This type of injury was something entirely new to us and the apples were forwarded to Mr. W. A. Ross of the Vineland Station, Ontario, laboratory who tentatively identified the insect as the apple sawfly, *Hoplocampa testudinea* Klug. Later this identification was confirmed by Dr. A. M. Massee of the East Malling Research Station, Kent, England, to whom some of the larvae were sent by the Dominion Entomologist. This is the first known occurrence of this insect in North America. A brief survey showed that the species was present in parts of the city of Victoria and the adjoining municipality of Oak Bay over an area of approximately six square miles.

Distribution and economic importance: The apple sawfly is distributed over the whole continent of Europe but is more common in the north. It is the most important apple pest in many parts of Germany, Denmark, south-west France and Holland. It is found in most parts of England but appears to be only locally common and seasonal in abundance. Massee (2) states: "This insect is re-

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sponsible for much of the useless fruit grown in the apple orchards of England." The fruit is attacked as soon as it begins to form and by the time the apple is an inch in diameter the larva is full grown and ready to leave through a large hole in the side. The infested fruit falls to the ground either before or after the larva leaves it. In addition to the destruction of young fruit, a secondary injury is caused to many of the apples by surface feeding. The young larva, before it enters a fruitlet, may feed on the exterior of an adjoining one, which results in characteristic ribbonlike scars or deformity. The injury is quite different from that caused by the codling moth. Large cavities are eaten in the centre of the apple and there is always an opening to the exterior even at an early stage. The larva does not always complete its growth within a single fruit and if the first is insufficient for its use before it reaches maturity it passes to the next one and so a succession of young fruits may be destroyed. The cavities are full of black or brown messy frass which often exudes from the hole at the side. Infestation observed at Victoria varied from slight, to possibly 50 or 60 per cent.

Life History: The adults appear on the wing as soon as the apple trees come into bloom. In 1941 early apples were in flower in the neighbourhood of Victoria on April 10. The first sawflies were collected on April 18 but since they were quite numerous it is probable that they had begun to appear a week before that date. The proportion of males to females on April 18 was 4 to 1 and five days later 2 to 1. The adults are active only in bright sunlight and on dull days none could be found. They are swift in flight and not very easy to obtain, since the majority seem to prefer the blossoms on the upper branches of the trees. Only trees in full bloom were visited by them and as soon as the petals began to fall they left those trees for others. None were found on trees from which the bloom had dropped. According to our observation in 1941 the adults were on the wing for about three weeks.

Oviposition was not observed although the females were frequently watched as they crawled over the blossoms. The egg is inserted from the outside of the calyx just below a sepal, is pushed right through and may be found at the base of the filaments or near the style, the position being indicated by a small rusty-brown spot which is often partly obscured by pubescence. Those seen by us were white, glistening, oval and about 1 mm. in diameter. According to English and German authorities the average number laid is 12 or 13 with a maximum of 20 to 22. The incubation period is about 13 days. Some of the larvae remain within the calyx after hatching, while others leave the egg pocket and feed on the exterior of the young fruit, or on an adjoining one, forming a characteristic lineal scar. These lineal scars were found to be much more frequent on small-sized varieties of apple, such as crabs, with many fruits to a cluster, than on large-sized varieties.

The larva: The larva is creamy-white with a dark brown head and a black or dusky chitinous plate on the upper surface of the anal segment. When mature it is about 12 mm. in length. There are 6 abdominal and one anal pair of prolegs. On the labrum, in the middle of the two muscle attachments, there is a dark brown triangular spot. Like those of many other species of sawflies, the larvae have a most offensive odour which in this case resembles that of a pentatomid bug. They are active and capable of crawling some distance after dropping to the ground, which they do in June when mature. They then enter the soil to a depth of four to eight inches and form compact, oval, brown cocoons, 7 to 8mm. long and 3 to 4 mm. wide, those of females being the larger. During the rest of the season the insect remains as a larva within the cocoon and pupation takes place in the following

spring. Velbinger (6) states that the diapause lasts 9 months where the development is annual and 21 months where it is biennial. The developmental period of the larva in the cocoon is probably dependent upon the moisture of the environment at the time of spinning and upon the temperature during the first hibernation. Moisture is all-important to the welfare of the insect during the diapause. From a considerable number of cocoons collected by us only three adults emerged, which is attributable to an insufficient moisture supply.

The adult: The adult sawfly is black on the dorsal surface except the head, which is orange yellow with a black patch between the eyes. The eyes are black. The antennae are yellow with a dusky or black mark at the base of segments 3, 4 and 5 on the upper side. The tip of the abdomen in both sexes is yellow but this is more apparent in the males. The ventral side of the abdomen and the legs are orange yellow. The wings are transparent, somewhat iridescent, with brownish or black veins and costal margin with the stigma dark except at the apical end which is yellow. The females are about 6 mm. long, the males slightly smaller.

H. testudinea reproduces both bisexually and parthenogenetically. According to Theobald (1) a second generation has been observed occasionally in England. This was not confirmed by Velbinger (6) in Germany. The second generation is said to attack large apples in July and August. It is possible that a second generation could occur where higher summer temperatures are general.

The apple sawfly was undoubtedly introduced in balled nursery stock. Even with the most careful examination of the soil it is difficult to detect the cocoons, for being covered with grains of earth they cannot be distinguished except by their symmetrical outline, from a small piece of soil. To collect many of them, even where they are known to be numerous, has been found quite a difficult matter and the most feasible method is to float them out of the soil in a tub of water.

Impracticability of extermination: The short survey carried out in 1940 showed that the sawfly had already spread over a very considerable area of city and suburban lots in which apple trees were extensively planted. The question of extermination before the pest could spread further was immediately considered, but the actual limits of the infected area were not then known nor were the means available for carrying out a campaign. It was decided at a conference of Dominion and Provincial officers that scouting should be continued in the spring of 1941. The limit of the infested area in 1941 was found at a point six miles north of the city, including the whole of the municipality of Oak Bay, the Gordon Head and Cadboro Bay districts and the greater part of the city of Victoria, an area of approximately 16 square miles. The sawfly was not found in Victoria West nor in Esquimalt, but appeared to have spread in a northerly and northeasterly direction, possibly following the general trend of the prevailing winds. It was seen at once that an extermination campaign involving the destruction of all apples over a period of 2 years would be a colossal undertaking. A census of apple trees within the affected area, including a two mile zone outside the actual limit of infestation, showed that more than 23,000 trees would have to be dealt with. The time limit during which the fruit must be stripped being only fourteen days at the most, probably 400 or 500 men would be needed for the work and the impossibility of obtaining such a force under the difficult labour conditions created by the war will readily be appreciated. Therefore, extermination of the sawfly cannot now be regarded as a possibility and recourse must be had to spraying to keep it in control.

Control by spraying: Fortunately, one spray applied at the proper time will usually give good control of this species. In England a spray of free nicotine (98%) at the strength of 8 oz. to 100 gallons, with or without lime-sulphur, applied within a week after petal-fall, is recommended (2, 3, 4). As the object is to destroy the eggs, a coarse driving spray directed at the calyces should be used. The addition of a spreader is desirable, but not essential. Lead arsenate will not control the sawfly but may be added to sprays for the purpose of controlling other pests. Velbinger (6) states that the best control of *H. testudinea* in Germany was obtained by spraying with a strong solution of quassia; or with quassia in combination with arsenic, copper, and lime, at petal-fall. Contrary to English data, he states that nicotine with lime sulphur and lead arsenate was ineffective.

At Victoria in 1941 experiments with nicotine sulphate in a 1½ per cent summer oil spray gave control equal to that obtained in England with free (98%) nicotine. The nicotine sulphate was used at a strength of 1 to 600, and lead arsenate was added at the rate of 2 lbs. to 40 gallons. As this trial was conducted in city gardens where no satisfactory check trees could be used owing to the number of different varieties of apple in the gardens, the result must be taken only as an indication. Infestation was kept down to 3.9 per cent in the case of one series of trees and to 5.2 per cent in another, while unsprayed trees in a nearby garden showed as high as 80 per cent attack. The addition of lead arsenate had a good effect in clearing the foliage of sundry other pests such as apple and thorn skeletonizer and other caterpillars.

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THE ADVANCE OF THE CODLING MOTH IN BRITISH COLUMBIA

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The codling moth, *Carpocapsa pomonella* (L.), has increased to such an extent during the last fifteen years that it has now become the chief limiting factor in apple production throughout the apple producing areas of the southern Interior of British Columbia. Until about 1915 the codling moth was practically unknown in the Interior. Although infestations were reported at Victoria in 1900 and at Kamloops and Kaslo in 1905, these infestations evidently covered only small areas. They were believed to have resulted from the importation of wormy pears from California and wormy apples from Ontario.

In 1912 codling moth was reported from Armstrong and Rutland. At Armstrong worms had evidently been imported in nursery cases from Oregon, and at Rutland in settlers' effects. Prompt eradication measures were carried out. Weather conditions were helpful for in the spring of 1913 a heavy frost prac-

tically eliminated the apple crop in these districts. No codling moths were found in a careful inspection the the following year.

An outbreak of *C. pomonella* was discovered in the north end of the town of Kelowna in 1913. It was believed to have started from infested railway cars. Orchards were banded and sprayed and all wormy fruit destroyed during the summers of 1914 and 1915 and as far as could be determined this infestation was eliminated. Within Kelowna city limits in 1915 four government power-sprayers commenced operation directly the blossoms fell. Three thorough sprayings with arsenate of lead were administered and the trees banded and patrolled. Only seventeen larvae were found during the season in the Kelowna city limits.

Just about the time it was believed no worms existed in the Okanagan, more infestations were discovered at several points in the Valley. In August 1915 codling moth was found at Westbank. Twenty-four orchards were involved, forming an area of about 200 acres. The trees were immediately sprayed and the fruit ordered packed at the packing house instead of in home orchards. Any fruits showing signs of worms were destroyed in a boiler rigged up on the beach. Trees were banded and patrolled. No apples, pears, or quinces were allowed to leave the district without first being inspected. The infestation varied in these orchards from 1 to 5 per cent.

Until 1913 codling moth control work had been in charge of the late Thomas Cunningham, chief orchard inspector for the Province, a man who took most vigorous action whenever he believed the circumstances warranted—and that was invariably so where *C. pomonella* outbreaks were concerned. In 1914 and 1915 the work was directed by W. H. Lyne. In 1916 the Horticultural Branch took over the codling moth control work in the Province. P. E. French was in charge of the North Okanagan and C. P. R. Mainline districts, the writer from Kelowna to the International Boundary. The spraying of orchards and the destruction of infested fruit in quarantined districts was continued. An area of 65 acres was found to be infested at Walhachin in the fall of that year.

Spraying, band inspection and destruction of wormy fruit was continued throughout 1917. As no worms were found in the Kelowna city area during 1917 this area was assumed to be free of codling moth. Of the work at Walhachin, P. E. French reported as follows: "Methods of eradication employed here were similar to those practised at Okanagan Landing. Very thorough work was done by Mr. Buckell, who was in charge of this work at Walhachin for the season."

In 1918, all codling moth control work in the Interior came under the supervision of the writer. H. H. Evans was in charge at Vernon, Mr. Chesbro at Westbank, and C. Barlow in the Salmon Arm area. At this time there were about five hundred acres under quarantine in the Interior of the Province. Walhachin, Vernon, and Westbank districts were involved. Two sprays of arsenate of lead were applied, the calyx spray commencing May 20, and the second spray on June 20. Twelve thousand trees were banded and the bands inspected five times during the season. On the third inspection, three worms were found. Two more inspections followed this, but with no sign of the pest.

The results of the work at Westbank are shown in the following figures: In 1916, 340 worms were found; in 1917, 58, and in 1918, 3.

On the recommendation of P. E. French and R. C. Treherne, Dominion Entomologist for British Columbia, the policy at Vernon was changed in 1918. Instead of spraying and banding the trees in the area under quarantine, the apples on about 50 acres were purchased by the government, picked before maturity and destroyed. In band inspections no worms

were found. Although the worms had apparently been eradicated in this area, two new infestations were found in the Vernon area in 1918. Four properties aggregating 15 acres were infested about one mile north of the quarantined area, and a new outbreak was discovered in the town of Vernon. In all, seven additional properties were quarantined.

At Westbank the work continued during 1919. No worms were found in the district. At Vernon in 1918, 394 specimens were captured. From the same area in 1919, 195 were taken. However, in 1919 a new infested area was discovered, and from this area 178 specimens were taken, bringing the total captured in 1919 to 372. All orchards adjacent to those infested were held under quarantine.

Three hundred and seventy-eight foreign refrigerator cars were inspected for codling moth at Okanagan Landing and 88 at Similkameen during this period. At Okanagan Landing 203 specimens were taken. Twenty larvae were found in a single car.

In 1921 an outbreak of codling moth was located on the K.L.O. Benches at Kelowna and in 1922 outbreaks occurred at Kaleden and Summerland. Rewards were offered for the detection of codling moth in new areas; $20.00 for the detection of worms in an orchard located in a district where worms had already been found, but outside an actual quarantine area; $100.00 for the detection of codling moth in a section or district in the Okanagan where no quarantine existed. Two rewards were paid in 1922, $20.00 in the Kelowna district and $100.00 in the Kaleden district.

In 1922 according to the report of H. H. Evans, 990 refrigerator cars were inspected at Revelstoke, Kamloops, Penticton, Keremeos, West Summerland and Okanagan Landing. Of this total 249 were super-heated. For superheating work at Revelstoke, steam was supplied by the round-house boilers, carrying a pressure of from 80 to 100 pounds. Since the distance from boilers to cars was 300 to 600 feet, the low and variable pressure gave unsatisfactory results. Car temperature above 170° after 10 minutes heating were attained at Okanagan Landing and results in such cases were satisfactory. Moisture condensation is much more pronounced in cars treated under low temperatures and pressures than with higher pressures and temperatures. Excess moisture was found to be undesirable.

Through 1923, 1924 and 1925 the codling moth continued to survive in the Okanagan Valley and though there was considerable success in cleaning up certain areas, most of the officials in the Department came to feel that quarantine measures were becoming of less value each year. The following table shows the areas infested in 1924 and larvae and pupae captured in 1923 and 1924 in the Okanagan district:

Table 1. Status of Codling Moth in Okanagan District, 1923-1925

	Acres Sprayed 1924	Acres To be Sprayed 1925	Larvae and Pupae Found 1923	Larvae and Pupae Found 1924
Vernon:				
Swan Lake	55	0	0	0
Ok. Landing	55	35	541	14
Winfield	110	210	0	99
Kelowna:				
K. L. O.	324	324	196	88
Benvoulin	0	50	0	9
City Area	205	205	1278	2319
Glenmore	0	200	0	160
Rutland	0	60	0	8
Penticton:				
Dog Lake	291	316	283	29
Kaleden	20	0	3	0
Green Lake	7	7	0	192
Totals:	1067	1407	2301	2918

The year 1925 was the last of general quarantine areas. W. H. Robertson, Provincial Horticulturist, reported as follows in 1926: "It was decided by the government that the old system of quarantine areas and the spraying of

same for the control of codling moth would be discontinued at the end of 1925. Districts were, however, given the opportunity of forming compulsory spraying zones. An Order in Council was passed which made this possible upon receipt of a petition from any district signed by 60 per cent of the growers. Your Branch also thought it advisable that there should be certain regulations as to the number of spray machines. This requirement was finally placed at one 4-horsepower machine for every 50 acres. Regulations were also drafted based upon the 'Agricultural Act,' Part II, R.S.B.C. 1924, which outlined the actual spraying requirements and penalties for non-compliance. Because of certain deficiencies in the Act under which this work would have to be carried out no spraying zones were formed. It is expected, however, that with the amendment to the Act which it is proposed to make at the next meeting of the Legislature there will be a number of zones established during the coming year."

A certain amount of work, however, was still carried on. At Okanagan Landing and Kamloops, spraying and banding were done by the provincial government in 1926 and paid for by the growers. This work was continued in 1927 at the above points and in the city of Kelowna. At Salmon Arm, growers sprayed an area in quarantine in 1925, 1926 and 1927 under supervision of the Horticultural Branch and the cost of band inspection was borne by the government. The Salmon Arm quarantine was lifted in 1927 when no further infestation was found.

In 1929, trees were sprayed throughout the Vernon City area and the cost assessed to the lot owners. This work was continued in this area until 1941, when it was done by contract under the supervision of the city.

Aside from spraying work in and around the Vernon district by the Department of Agriculture, all quarantine work was dropped in 1926 and the Okanagan Valley south of Vernon was assumed to be generally infested with codling moth. Though many sections then were commercially free of the insect, infestations were so numerous and widespread that it was conceded by officials and most growers that the codling moth had become a pest with which the apple industry had to learn to live.

EFFECT OF LIME AND LIME-SULPHUR ON THE LARVICIDAL VALUE OF CRYOLITE[1]

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Apparently it is generally believed that because of chemical incompatibility, sodium aluminum fluoride (cryolite) should not be used in a spray mixture containing lime or lime-sulphur. So far as can be determined, however, there has been presented no evidence of incompatibility in terms of insecticidal effectiveness.

Carter (1931) mentions that sodium silicofluoride (sodium fluosilicate) and lime react to precipitate the insoluble fluoride of calcium which evidently is considerably less toxic than the more soluble salts such as sodium fluoride. Barium silicofluoride, according to Carter (1932), is likewise incompatible with lime as well as with lime-sulphur solution. Popov and Rasina (1939) report that the addition of lime to sodium fluoride and sodium silicofluoride lowers both the phytocidal properties and the insecticidal value of these compounds. On the other hand Hockenyos (1939) states that as a contact insecticide, sodium fluoride was more quickly lethal to the

1. Contribution No. 2159, Division of Entomology, Science Service, Department of Agriculture, Ottawa, Canada.

American cockroach when used with 50 per cent by weight of calcium hydrate than when used alone. He is of the opinion that the calcium hydrate reacts with or absorbs the oily film covering the integument and the fluoride then penetrates by osmosis.

Field experiments in codling moth control carried out at Kelowna, B.C., in 1939 indicated that as an adjuvant for cryolite, casein-lime might be superior to ammonium oleate or blood albumin. Further experiments were undertaken in 1940 and 1941 to determine the effect of varying quantities of lime on the larvicidal value of the cryolite-casein-lime mixture [2]. Several plots, each consisting of 4 McIntosh, 1 Newtown and 1 Stayman tree, were sprayed with mixtures composed of natural cryolite 3.75 pounds, lactic casein 0.5 ounce and high calcium hydrated lime in amounts varying from 4 ounces to 4 pounds per 100 gallons of water. Four cover sprays were applied in 1940 and five cover sprays in 1941. Check plots adjoining the experimental plots were sprayed with lead arsenate 3.75 pounds, casein 0.5 ounce, lime 4 ounces. Each year in the single second brood spray, cryolite was substituted for lead arsenate in the check plots.

Table 1. Effect of Lime on Cryolite in Codling Moth Cover Sprays

	Average Per Cent Wormy Fruit	
	1940	1941
Cryolite-casein-1 oz. lime	10.4	.....
Check adjoining (1)	9.4	.....
Cryolite-casein-4 oz. lime	9.1	9.5
Check adjoining (2)	9.4	10.5
Cryolite-casein-16 oz. lime	8.0	15.6
Check adjoining (3)	12.5	10.5
Cryolite-casein-64 oz. lime	.....	22.3
Check adjoining (4)	.....	12.3

Table 1 gives results in terms of fruit infested by codling moth at harvest.

While lime used at 0.25 pound per 100 gallons of spray did not measurably lower the larvicidal value of cryolite, four pounds appeared to be detrimental. The addition of one pound of lime per 100 gallons evidently had little effect.

Table 2. Effect of Lime-Sulphur and Elemental (Ground) Sulphur on the Larvicidal Value of Cryolite

Materials Per 100 Gallons	Number of Larvae	Av. Per Cent Stings	Av. Per Cent Larval Entries
Cryolite 3.75 lb. - casein 0.5 oz. - lime 4 oz.	231	14	29
Same but with added lime sulphur 1.6 gal.	217	6	60
Same but with added elemental sulphur 4.5 lb.	229	13	35
Check—no spray	217	1	70

A laboratory experiment in which natural cryolite was used with lime-sulphur and with elemental sulphur, gave the results noted in Table 2. Newly hatched codling moth larvae were allowed to attack individual apples that previously had been sprayed with the experimental mixtures. The apples were examined for stings and entries after two weeks. The experiment comprised three replicates of each material.

Although elemental sulphur had little influence on the larvvicidal value of cryoüte, lime-sulphur at equivalent sulphur concentration apparently had a detrimental effect. The results were consistent in each of the three replicates.

2. The field experiments were co-operative with the British Columbia Horticultural Branch. Mr. B. Hoy, in charge of the Kelowna office, supplied the sprayer and did much of the spraying and fruit checking. The staff of the Vernon laboratory was responsible for the remainder of the work.

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A NOTE ON LAELIUS SP., A PARASITE OF THE CARPET BEETLE ANTHRENUS SCROPHULARIAE (L.) (Hymenoptera, Bethylidae)

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On August 3, 1941, a mass of floor sweepings containing beetle larvae was sent in to the entomological laboratory at Kamloops, from Mazama, Osprey Station, about 30 miles north-west of Penticton; Mr. G. Allen Mail very kindly handed the debris over to me. It contained dermestid larvae and the chewed-up remains of several adult *Anthrenus scrophulariae* Linn. I kept the mass caged and secured over a dozen fresh beetles of this species.

Amongst the trash were a number of old larval skins in which beetles had pupated; three of these skins contained a mass of silk enveloping four silken pupal cases lying in the same axis as the dermestid skin. Attached to one mass, and partly enveloped in the silk, was the remains of a tiny dark hymenopteron while another lay nearly detached in the rubbish. Both wasps were somewhat battered, but were obviously parasites of these beetles.

I sent the specimens to Dr. G. S. Walley who turned them over to Dr. O. Peck. In his reply, Dr. Peck says, in part, ". . . this hymenopteron (Bethylid) agrees closely with the description of *Laelius occidentalis* Whittaker although somewhat lighter in colour. *L. occidentalis* has been known, up until now, only from the type; this was taken on a window in Chilliwack, B.C., and was described in the Trans. Ent. Soc. London (1927-28): 387-8 (1 fig.) . . . nothing is known of its biology except through other species of the genus. In this regard it is perhaps well for me to draw your attention to the method of pupation. Your letter of August 19th states that there are three or four pupal cases *in* each larva, suggesting internal parasitism which is contrary to the external parasitism in this genus (Vance and Parker, 1932, Proc. Ent. Soc. Wash. **34**: 1-7). However, Mr. W. J. Brown tells me that *Anthrenus* pupates within the last larval skin so that an external parasite may well appear to be internal."

Now the last larval skins of *Anthrenus*, in which the cocoons occurred, were intact so I could not see how the *Laelius* grubs could be external feeders without destroying this exuviae; in the one specimen I have left, there is no sign of the pupal case of the beetle. In that priceless book "Entomophagous Insects", Clausen, speaking of the attacks of *Laelius* adults on their hosts, says that they sting their victims — "The females of the genus *Laelius*, which attack the larvae of Dermestidae, bite away the covering of long hairs on the venter of the abdomen before depositing their eggs (Howard, 1901) . . . "In *Laelius anthrenivorous* Trani, the female . . . . chews the throat, apparently with the object of injuring the cervical ganglion. The complete process of subduing the host may require several hours." For reference, I quote this passage from The Insect Book by Leland O. Howard, pp. 34-35, "Life History of a Parasitic Wasp":

"The Laelius is a little, black, slender, active, four-winged fly; and the female, when it finds one of these dermestid larvae, at once jumps upon its back and clings firmly, in spite of the struggles of the victim. As soon as the poor beetle larva quiets down a bit, Laelius places herself crosswise over the thorax and, curling her abdomen around under the side, inserts her sting just behind the second or third pair of legs, paralyzing the dermestid instantly, the sting apparently having entered one of the large thoracic nerve ganglia. Then the parasite relaxes its hold and begins

pulling the legs and hairs of its victim with its mandibles, its antennae vibrating in a contented manner. The pulling of the legs is evidently an attempt on the part of the parasite to see if the stinging has done its work with perfect effect. Having satisfied herself by all sorts of tests that the paralysis is complete, she proceeds to lay an egg, attaching it to the skin of the dermestid on the under side of the body, first pulling out the hairs carefully so that the egg can be firmly attached to the skin. If in the course of this operation, or even before the egg is laid, another dermestid larva comes within her range of perception, she leaves the first victim, mounts and stings the second, or even a third or a fourth, each time testing the completeness of the paralysis with the utmost care. Before attaching the egg she thrusts her sting into the spot several times, apparently making an orifice through which the larva, after hatching, can thrust its head, or which it can at least enlarge easily so as to insert its head. The egg is oval, soft, translucent, about a third of a millimeter long, apparently has no peduncle, and is not very firmly attached to the skin of the dermestid. From one to six eggs are laid upon a single victim. In a few days the larvae hatch, yellow in color and very indistinctly jointed. Immediately on hatching, their mouths are closely applied to the skin of the paralyzed dermestid and they begin to grow, not so rapidly as the somewhat similar Euplectrus, which will be described in a succeeding chapter, but still rather rapidly, reaching full growth in from ten to fourteen days. When full grown, a group of these larvae with their heads inserted at a central point, look not unlike the petals of a curious flower growing out of the shrivelled dermestid larva. When only one Laelius larva occurs upon a host it sometimes enters the sucked-dry skin and spins its cocoon within it, but generally the white, rather loose, silken cocoons are spun outside the skin of the dermestid, which shows large holes where the parasitic larvae have been at work."

Now it is true, even as Mr. W. J. Brown mentioned, that *Anthrenus* pupates within the last larval skin; this skin takes on the form of a broad oval, sharply pointed at each end like a canoe very wide in the middle, with the bluntly-oval, delicately skinned pupa lying inside it. This is precisely the form of the exuviae of parasitized *Anthrenus* that I have but instead of the beetle puparium, four silken *Laelius* cocoons lie inside the split-open last larval skin which is otherwise intact. If the *Laelius* larvae had been external feeders, this last larval skin would have been shrivelled or at least, punctured; it is intact. Therefore in this instance at least, it appears as if the *Laelius* larvae had attacked the recently-formed pupa of the beetle. At first this did not seem feasible because the summer brood of *A. verbasci* (for comparison) is a rapid one and the pupa hardens quickly, but development of this beetle through this (1941) winter shows that the stage of the perfectly soft, white, helpless *Anthrenus* pupa, lying exposed in the widely-split-open last larval skin, may extend for over three weeks; at such a time a *Laelius* could do what she liked with it and her grubs could feed upon it externally, leaving the larval skin intact, and form their silken cocoons in this skin.

I am greatly indebted to Dr. O. Peck for his comments on this insect and for suggesting that this record may be worth publishing.

Agabus ontarionis Fall. This dytiscid water beetle was unknown from British Columbia until June 8, 1941, when G. J. Spencer took a series of teneral adults. His specimens are from Bachelor Swamp, between Pass Lake and Lac du Bois, high on the ranges north of Kamloops. A month or two later the meadowy swamp had dried up.—Hugh B. Leech.

INSECTS AND OTHER ARTHROPODS IN BUILDINGS IN BRITISH COLUMBIA

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This paper consists of a series of brief records of certain insects, sowbugs and mites which have come into my hands in the last ten years in this Province; the buildings mentioned are dwellings either permanently or temporarily occupied, and in a couple of instances, are greenhouses. Insects and mites infesting stored products in mills, factories and warehouses are not included; they have been written up by the late Kenneth Jacob in a paper of some length which the department of Zoology of this University hopes to publish before long.

Of the very large number of arthropods that might come into dwellings, some are indigenous, most are accidental and a fair number are introduced species infesting materials in the houses. This list is confined to those native and introduced and doubtful species about which complaints or enquiries have come to me over a period of years or those which I have intercepted myself; the common species of domestic pests attacking foodstuffs, of which we have a very large number, are omitted and mention is made only of those not hitherto recorded for the Province or of special interest otherwise, which have become established here or are accidental intruders. In a few cases some are mentioned which are conspicuous by their absence.

Of Arthropods not Insects

Acarina. Two heavy infestations of mites were sent in during the autumn of 1941, one *Aleurobius farinae* Degeer infesting a large warehouse for imported cheese, where the mites had suddenly become so plentiful that they formed a heavy dust around the bases of the cheeses. It was not possible to order fumigation and clean-up measures involved two thousand 80 to 90-pound cheeses; by experiment I found that the finest spray with the mosquito repellent "Sta-way" instantly wetted the greasy mass of dead and living mites, so I suggested that the operators try it out with all due care to its possible poisoning the cheeses or affecting their flavour. They reported entirely in its favour.

The other mite was *Glycyphagus domesticus* Degeer sent in from Nanaimo where it was reported by a medical man as producing an irritating rash on human beings. This mite is the cause of the so-called "Grocer's itch" in England; as far as I can determine, this is the first record of it in Canada.

Isopoda. Up to the present I have collected only five species of sow-bugs in buildings, though a sixth, *Lygidium gracile* (Stimpson) is common in certain lands and woods near and on the University campus.

Up to the last two or three years, the only ubiquitous sowbug that invaded homes every autumn was *Porcellio scaber* Latreille, though I recovered *Porcellio rathkei* Brandt in October 1929 at the University. Recently, however, *Oniscus asellus* Linn. has increased tremendously, is abundant in neighboring wild lands near Vancouver and last autumn (1941) occurred in gardens of West Point Grey. It is the largest sowbug to be found locally and is a very active species. I first found it here in 1929, in the Stanley Park greenhouse, and have taken it occasionally since, but it is common now and widespread. Also in greenhouses, have cropped up *Armadillidium vulgare* (Latr.) and *A. quadrifrons* Stoller; the latter is very abundant in one of the Fraser Valley greenhouses where it tunnels readily into flower pots, eats away root systems of plants and will not respond to control measures that keep down the other species, *P. scaber*, which also

occurs in these houses. These two species of *Armadillidium* roll up into a ball when disturbed.

Chilopoda. The house centipede *Cermatia (Scutigera) forceps* (Raf.) has twice been brought in — once from an abattoir where there was an active colony in one of the partitions between two rooms, and the second on April 10, 1939 when a large, healthy speciment was caught in a beer parlor in the city.

The garden centipede *Scutigerella immaculata* (Newport) has also twice been reported—once in small numbers in an outdoor compost heap in Vancouver, and in January, 1942, from certain large greenhouses near Langley where it was destroying 8-inch-high tomato plants in 100 yards of hot house.

Araneida. This province is a paradise for spiders and offers a most promising field for collecting and systematic work. House spiders of several species are a curse to the housekeeper at the Coast; they invade dwellings in swarms every autumn and spin webs for the next six months. They are best detected by noting the location of the spiderless web by day, and at night, suddenly flicking on the electric light or a flashlight, when the culprit can readily be seen and killed with a fly swatter before it runs to cover. A certain restraint is necessary when hitting them because the large juicy ones leave a conspicuous mark on wallpaper or kalsomine if squashed with too much enthusiasm.

The black widow spider *Latrodectes mactans* Fab. is widely distributed in, and apparently restricted to, the dry belt of the Interior and the drier portions of south eastern Vancouver Island and the Gulf Islands. It seldom enters houses but is very common in woodsheds, outdoor toilets and machine sheds. In the Nicola area at about 2900 feet, I have found its webs completely covering the corners and back of a carriage shed. In the Kamloops area it occurs up to 3100 feet only and seems to extend down the Fraser Canyon to just below Lytton.

Of Insects

Thysanura. A house-infesting Thysanuran, the silver fish, *Lepisma saccharina* L., has turned up a few times in the last decade but seems unable to form successful colonies, while the fire brat, *Thermobia domestica* Pack., is widely but thinly distributed in Vancouver. Every now and then small colonies are reported, chiefly from apartment houses, but neither of these species attains the density of numbers acquired by them in Toronto, Ontario.

Orthoptera. Of house-frequenting Orthoptera, *Ceuthophilus agassizi* (Scud.) occurs frequently in basements in autumn, apparently coming in from gardens, but seems unable to survive the winter drying-out and soon disappears. I have one unusual record of the giant cave-cricket *Tropidischia xanthostoma* Scudder being taken in one of the upstairs draughting rooms of the engineering department of the University in July, 1941; it must have climbed up an outside wall and hopped in.

The European house cricket *Gryllus domesticus* Linn. has never materialized as a pest in this city as we thought it would do eight years ago when it was first discovered, although it still persists in small numbers in the basement of a local golf clubhouse.

Atropidae. Of the Atropidae or book lice, two species are widespread, occurring in basements of very many homes but rarely increasing sufficiently to become a nuisance. A small pale-coloured one is very general and may become a pest, but the second is more interesting, being larger, nearly black and possessing rudimentary fore wings (only). Now the world-wide *Liposcelis (Troctes) divinatorius* (Muller) is nearly black but is wingless so this local one may be undescribed or a species of *Clothilla*.

Hemiptera. I need mention only two species, *Leptocoris trivittatus* (Say), the

box-elder bug which has been sent in with enquiries in increasing frequency from the Okanagan Valley in the last five years, with complaints of its invading rooms, and the big Coreid, *Leptoglossus occidentalis* Heid. which is either increasing in this vicinity or is coming more into public attention. Personally, I think it is increasing because I have collected it several times the last few years in December when it seeks shelter in the house and up to five years ago I had never taken it locally; it is also being sent in with enquiries. It either feeds upon or shelters in holly, whence it can sometimes be obtained by beating.

Lepidoptera. Only a few house-infesting moths need be mentioned. Since 1938 I have found Purina manufactured "Fox-pelting Chow" biscuits to be the best medium for raising clothes moths that I have yet come across. One large culture in a crock has been going continuously for nearly 3½ years without any additions of food; in the last 2 years it has become infested with the spider beetle *Ptinus ocellus* Brown and still produces numbers of both insects the year round. For two years the moths (*Tineola biselliella* Hummel) were the largest and healthiest specimens I have yet raised but the food supply now seems to be running low and the size of moths is decreasing.

The scavenger bulb moth or brown house moth *Borkhausenia pseudospretella* Stainton is a very persistent but never plentiful intruder, the larva feeding usually on dried forgotten carrots in the basement but there are indications that it eats animal products such as woollens, as do the clothes moths.

The white-shouldered house moth *Endrosis lacteella* Schiff. flourishes enormously in commercial blood-meal for gardens; I have had a colony going for two seasons in this medium, which yields clouds of moths in late summer and early autumn. The caterpillars may be taken from it all through the year. This species, like the preceding, is generally regarded as a decaying-vegetable feeder so its success on blood meal seems unusual.

I have only once encountered the tapestry moth, *Trichophaga tapetiella* (Linn.) emerging in numbers from an ancient couch in a rest room in a garage at Spence's Bridge. The infestation probably came in and died out with the couch.

Conspicuous by its rarity is the meal snout moth *Pyralis farinalis* Linn.; I have encountered it only once in 15 years, in the buildings of the biological station at Nanaimo. Mr. H. B. Leech has found the larvae numerous in mangers in a horse barn at Salmon Arm.

Coleoptera. Of the large number of beetles that invade dwellings, the majority are stored product pests. Some, however, come in for hibernation and of these some seek shelter but remain active all winter. Of those merely seeking winter quarters, the weevils *Brachyrhinus sulcatus* (Fab.), the black vine weevil, and *B. ovatus* (Linn.) the strawberry root weevil, are common every year and sometimes very abundant and this last year the clay coloured weevil *B. singularis* Linn., recently recorded in Victoria by Messrs. Downes and Andison, has made its appearance in West Point Grey, entering homes for hibernation. Of stragglers that seek shelter but remain active all winter, the ground beetles *Pterostichus* sp. and *Pemphus (Scaphinotus) angusticollis* (Fischer) are the chief; the latter eats dead or disabled sowbugs and is a regular nightly attendant at the dish from which household pets are fed, coming out when the first rush is over.

An accidental intruder but one which comes into buildings in summer is the notorious Stink beetle *Nomius pygmaeus* Dej., probably the most concentratedly malodorous animal for its size in the world. For some years now I have checked up reported flights of this beetle and find that their presence in towns can be associated with forest fires; when the

horizon is blotted out by smoke, these stinkers may arrive. Apparently they are forest dwellers which are driven out by the fires and may then travel long distances, scattered by the smoke. In the summer of 1938 a very extensive fire ravaged the Campbell River area on Vancouver Island and the beetles appeared again and were reported from several spots in Vancouver. They gathered under timber in one down-town lumber yard and remained there several weeks. A workman of the place told me of their potency, of their restricted area of temporary shelter and of the complete peace in which the men left them. He remarked on the fact that they did not scatter through the mill or invade nearby residences. It is possible that the particular block of lumber beneath which they sheltered happened to be in a certain degree of sap fermentation which was attractive to the beetles and held them until they either died out or returned to the woods when the fires died down. They were probably carried to Vancouver by the then-prevailing westerly winds, flying high over the pall of smoke. Dr. M. H. Hatch (1931. Monthly News Letter [Puget Sound Academy of Science] **3** (9), issue of September 1) has also recorded it as a household pest, and has given a summary of its habits.

Of the many beetles attacking stored products in this province I mention only a few, conspicuous for one reason or another.

The meal worms *Tenebrio molitor* Linn. and *T. obscurus* Fab. are relatively rare; the rice weevil *Sitophilus oryzae* Linn. occurs ten times for one infestation of *S. granarius* Linn.; the spider beetle *Ptinus ocellus* Brown and the saw-toothed grain beetle *Silvanus surinamensis* Linn. elicit more enquiries from harassed citizens than any other beetles, both of them, especially the spider beetle, flooding over an entire house, feeding on a wide range of cereal foodstuffs. I have raised the saw-toothed beetle on raisins and walnuts besides cereals. Of the flour beetles, *Tribolium confusum* J. du Val. occurs five times for one infestation of *T. castaneum* Herbst., the rust red beetle; *T. madens* Charp. I have recovered only once—from Departure Bay, Nanaimo. Along with the first two of these flour beetles, for the last three years I have had a colony of *Gnathocerus cornutus* Fab., the broad-horned flour beetle. An infestation of *Tribolium* is very hard to eradicate and requires most persistent house-cleaning. The varied carpet beetle *Anthrenus verbasci* Linn. and the buffalo carpet beetle *A. scrophulariae* Linn. have become established in Vancouver in the last 5 years; the former is becoming serious, the latter occurs very little.

Occasionally the minute cucujid beetle *Laemophloeus pusillus* (Schoen), which is usually an elevator pest, occurs in houses especially those in which old chicken feed or other broken grain is stored in the basement.

Some of these beetles need further comment. Of the Ptinidae, I have reared *Sphaericus gibboides* Boieldieu from saffron, cayenne pepper, curry powder and fish meal. With all these foodstuffs, the colonies die out in 2 to 3 years irrecpective of the amount of food present. *Trigonogenius globulum* Sol. has turned up twice in a dwelling, breeding in woollen fluff and trash. *Niptus hololeucus* Fald. was found in numbers in the basement of a hardware store at Fernie, B.C. (January 4, 1936. H. B. Leech). *Ptinus fur* Linn. the white-marked spider beetle seems to occur more in Victoria than in Vancouver; odd specimens are not infrequently found in Vancouver homes and are sent in. I have reared it on a variety of cereals but it soon dies out. *Ptinus ocellus* Brown (*tectus* Boiel.) is one of the most widespread and most complained-of pests in Vancouver. It was first sent to me from Prince Rupert in 1926 by a student, Dick Pilsbury, who reported it as occurring in devastating numbers on a fish-meal wharf; to clear the wharf and

its buildings of the pest, the workmen shovelled it into the sea with their fish-meal scoops and threw a great deal of the infested meal after it. Brown reported it (Can. Ent. **72** (6): 120, June, 1940.) first from Victoria, remarking that its discovery there by Mr. W. Downes in 1927 and 1928 was the first time it was found in America. It is now painfully common all over the lower Fraser Valley having apparently been spread by shipments of infested fish or other meal from Vancouver. I have reared it in a wide range of kitchen cereals, dried casein, buttermilk powder, blood and bone-meal and in commercial garden fertilizers which contain fish meal. This latter material, stored in basements, is the greatest single breeding place of this pest, whence it spreads out all over a home. Removing the host meal carries away the infestation and stray beetles soon die out.

Within the last year I have encountered three infestations in homes, of furniture beetles. The first trouble was caused by *Anobium punctatum* Degeer, which completely riddled the back of a china cabinet and part of the sides. I have all the wood in a cage and grubs are still working in it. The citizen who brought me the wood thought the cabinet had been bought at an auction. The second and third infestations of apparently this beetle occur in New Westminster in a piano which was brought round Cape Horn 50 years ago, and in a table imported from England 18 months ago; in both cases sawdust is being pushed out from holes which are appearing one after another in the wood. In the case of the piano, the infestation is of recent origin and must have arisen locally. The beetle would appear to have become established in this area.

The drug store beetle *Stegobium paniceum* (Linn.) *(Sitodrepa panicea)* crops up now and then at intervals in spices —cayenne pepper, all-spice and curry powder. I have a strong culture nearly 2 years old, in dried ginger.

Beetles of the family Dermestidae are well represented in British Columbia; I have 24 species so far. Some are very common, chiefly in the dry interior of the Province, and some are becoming common at the Coast.

Three species of fair size are equally numerous around Kamloops, freely entering unscreened houses. In my cabin above Kamloops at 3100 feet, all three turned up frequently, namely *Dermestes talpinus* Mann., *D. signatus* Leconte and *D. lardarius* Linn.; they were much attracted to drying bacon and to bread which was apparently fermenting in the heat in the bread box. Often a couple of beetles of one or other of these three species would arrive overnight and hide away under the bread. I have reared all three from larvae feeding upon dried insects or incompletely picked skulls and especially *D. signatus* from the trash at the bottom of used and vacated swallows nests. *D. lardarius*, especially, very readily lays eggs on, and the larvae develop in, a box of insects exposed for drying.

Attagenus piceus Oliv. was reared from a supply of casein powder recently received from Australia; *Anthrenus scrophulariae* (which is very common as far north as the Chilcotin) from trash on the floor of a public dance hall and from sweepings from the corners of a room, from dead insects, and once I raised two small larvae on a piece of old cow horn and secured the adult beetles; and *Orphilus niger* (Rossi) from dry insects.

Two dermestids need special mention here: *Anthrenus verbasci* Linn. the varied carpet beetle, and *Perimegatoma vespulae* Milliron.

Concerning *A. verbasci* the varied carpet beetle. Larvae of this insect turned up in the University collections, so I assembled them and cultured them out with a supply of dried insect bodies in a 3-inch diameter glass-covered tin box, on March 24, 1934. They kept on breeding in this tin until January 20, 1937, when the food supply was ex-

hausted and the larvae present had consumed even the dried bodies of their dead parents. So the mass was discarded and the larvae re-cultured with a supply of buttermilk powder. They throve on this medium and by April 10 many beetles had emerged from the pupae. They were allowed to increase again until May 15, 1939, when another mass of debris consisting of frass, exuviae and dead beetles had accumulated; many larvae were present so more buttermilk powder was added without cleaning out the tin. By spring 1941 the colony had died out. Apparently the last generation of beetles was infertile or the young larvae met hostile conditions because the dead bodies of many adults were present, unchewed by larvae. Thus this colony had been going in a 3-inch diameter tin for five years. This was the only trace of these beetles I had received in the Province.

Suddenly in November 1940 enquiries came in from five homes in Vancouver about large numbers of larvae which turned out to be those of the varied carpet beetle, appearing in clothes closets and in some cases all over the house. Most stringent clean-up measures were recommended and the potentiality for evil of these larvae was heavily stressed. Up to last autumn 1941, however, specimens of these larvae continued to come in from homes widely scattered over this city and from New Westminster. Apparently this beetle has become established as a household pest.

I have reared the larvae successfully on dried insects, on broken grains of wheat and chiefly on Purina Fox-chow biscuits which I use as a basic food for all household pests. The adults eat Fox-chow and raisins.

As far as a pest in insects collections is concerned, *Perimegatoma vespulae* Milliron is the worst thing I have encountered in this Province. In the summer of 1933 I was working in Upper Hat Creek valley and camping in the forestry cabin in Marble Canyon. As is my custom in summer, all insects collected were pinned out at night on cork strips and allowed to dry for one or two weeks before being transferred to store boxes. During the winter of 1933-34 I found larvae in these store boxes and on March 15, 1934, one pupal case from which a beetle emerged on April 12, 1934. I assembled all the larvae I could find and have cultured them out dozens of times since on every culture medium that I use—several cereal flours, fox-chow biscuits, casein, milk and buttermilk powders, dried lean meat, nut meats, spices of all kinds, and dried insects. They prefer perfect, fully labelled insect specimens, if possible type or paratype material or rare specimens, to everything else. They also feed upon bird skins and dried Crustacea in the museum, doing the best they can on this uninteresting food material.

In all these years of culturing hundreds of larvae, I have never yet brought one successfully to a pupa, much less to an adult. Every colony terminates with a large series of exuviae and, now and then, some dried larvae; frequently only exuviae remain and I cannot understand what happens to the larvae. The only adults I have obtained were accidentally found chiefly on the glass tops of the insect cabinet drawers and twice only in a box of bulk unpinned insects. At present I am culturing the larvae singly in glass-topped tin boxes and, in mass, in great heaps of insect bodies in tin boxes.

In 8 years I have obtained only 11 adults, 9 of them picked up accidentally where least expected and consequently few are perfect specimens.

The capacity of the larvae for entering apparently tight-sealing boxes is disheartening; they freely enter any of our own grooved and tongued cabinet drawers, any of our usual store boxes, they invade skull cabinets, bird and mammal cabinets, mailing boxes of insects, and I have repeatedly found them in ordinary drug-store tin salve boxes of unpinned insects. The larvae hatching from the egg must be infinitely small and capable

of entering very small spaces. I have never captured the adults nor found the larvae in the field, either at the Coast or in the Dry Belt.

Mr. W. J. Brown of Ottawa very kindly named the species for me and referred me to Milliron's description of it (in the Annals of the Ent. Soc. of America, **32** (3): 570-574, fig. 1. September, 1939.) In this article, Dr. H. E. Milliron of University Farm, St. Paul, Minnesota, describes it as a new species, reared in 1938 from a 20 to 25 year old demonstration wasp nest—hence the specific name *vespulae*. The only previous record of it in Minnesota was a pinned specimen in the University museum labelled "University farm campus, September 10, 1934."

I submitted a specimen to the late Mr. Ralph Hopping shortly after finding the first adult and he told me it was a *Perimegatoma* but could not name it to species.

Notwithstanding my most strenuous efforts at control, the pest is still very much with us and is constantly cropping up in the collections. Milliron found the species to be parthenogentic which would account for its prevalence all over our storerooms and its success in becoming established.

Finally, in this catalogle of stray or purposive invaders of dwellings in this area, may be mentioned outbreaks that have occurred several times in the late autumn, of vast numbers of minute pale brown beetles that swarm in basements, appearing suddenly on basement windows in such numbers as to practically shut out the light. They apparently breed on and emerge from wood that is stored for fire places, chiefly alder and coast maple. A series from one house, (November, 1933) yielded the following list (identified by Mr. H. B. Leech):—

Nitidulidae	*Epuraea* spp.
	Another genus
Cryptophagidae	*Atomaria* sp.
	2 other genera
Lathridiidae	*Coninomus constrictus* Gyll.
	Coninomus nodifer Westw.

Acknowledgments—I am deeply indebted to the following specialists who have named specimens for me over a number of years: Mr. W. J. Brown, Division of Entomology, Ottawa, Ont.; the late Ralph Hopping, and Mr. H. B. Leech, of the Dominion Entomological Laboratory, Vernon, B.C.

THE RESULTS OF FURTHER WORK DONE ON THE CONTROL OF GRAIN MITES IN BRITISH COLUMBIA*

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The need for conserving products vital to the well being of the British Empire and her allies is being continually stressed by our Governments. Food in all forms comes under the category of vital commodities to such an extent that at the present time some of these products are rationed, not that there is a shortage, but so that an adequate supply will always be available. Steps to conserve food products from deterioration due to insects have been taken by the Department of Agriculture from the beginning of hostilities, and the Division of Plant Protection has assisted other branches of the Service in this work. All elevators, mills, and warehouses where large stocks of grains and cereals are stored have been periodically inspected. During the past season it has been our privilege to assist Mr. Harold Gray, who is in charge of the Stored Product Insect Investigation Division and Dr. Beverley N. Smallman of the Board of Grain Commissioners for Canada,

* **Contribution No. 28, Division of Plant Protection, Production Service, Department of Agriculture, Ottawa, Ontario.**

who have been carrying on extensive work in the control of these stored product pests.

Mites may be found in practically any grain, and under normal conditions are not serious, but the lack of shipping has created a problem. Recently, we have had to put a large percentage of our crops in temporary storages, where turning the grain is an additional cost. Added to this, last year's harvesting weather was very poor and we have to consider a certain amount of tough or damp grain. Stored tough grains or grain where the moisture content is above normal, must be turned at regular intervals to avoid heating. Wherever the moisture content rises above fourteen percent we may expect a heavy infestation, unless the grain is stored in separate bins and turned at regular intervals.

In a well operated elevator the bins are numbered, or should be. If, for example, bins Nos. 3, 5 and 8 have a high moisture content in the grain, there is also a slight increase in the temperature. In a routine inspection the investigator should pay particular attention to these two points and draw samples from these bins first. If a bin is infested, samples should be drawn from both the top and the bottom. Where infestations are slight quite often the mites will be found only in the first few feet of the grain on the top of the bin and for a few feet up from the bottom. Usually grain in such bins will register a normal moisture content. Bottom samples should be drawn until there is no further evidence of infestation. Inspectors who are conversant with this work will have little or no difficulty in detecting the presence of mites since they give off a sickly sweet odour. If this odour is strong the infestation undoubtedly is heavy. Dr. Smallman stated that if the top of the bin were infested, the action of emptying it would not necessarily correct this, if the grain was simply drawn off that bin and placed in another. In drawing off the grain, that on the top of the bin settled down to about thirty or forty feet from the bottom before it coned in, and the mites on the top portion would then be deposited on the top of the new bin. To test this, I tied an eight-pound weight to a long rope, and buried it about two feet in the top surface of the wheat in a bin 26 feet wide and 100 feet deep. The bottom gate was then opened; the bin took 2½ hours to empty. Samples were drawn at intervals and showed mites in the bottom few tons and freedom from mites above that until the bin started to cone in. It was not until the grain had settled to within forty feet of the bottom that it coned in and the weight began to pull. This meant that the mites simply settled down as Dr. Smallman had stated, and would be deposited on the top of the next bin, unless that last thirty or forty tons were put over the cleaners. Re-examination of the wheat in the top of this new bin showed a decrease in the number of mites, indicating that some had perished in the transfer of the wheat, but there was still a nucleus to build up the infestation should other conditions become favourable. It is therefore suggested that where conditions of this nature exist, the wheat from the bottom and top of the bin should be put over the cleaners and driers.

Fumigation of elevators has always been a problem; it is difficult to get a gas that will penetrate through the mass of wheat and be effective in the control of mites. Some experiments have been made with chloropicrin and methyl bromide. Chloropicrin may be used under very low temperatures and at any place where the bin walls and floors are reasonably tight. A disadvantage is that this gas will not penetrate more than twenty-five or thirty feet within a thirty-six hour exposure, and so in large bins can be used only for surface fumigation. An experiment was tried out last season by Dr. Stillman: In one of our elevators he fumigated a large bin with methyl

bromide, using one pound of this gas to each thousand cubic feet. The gas penetrated through ninety feet of grain in a thirty-six hour exposure, giving a very satisfactory control of the mites.

In the use of gases, certain points must be remembered. (1) Will the gas be effective? (2) Is the cost of application economically such as to be recommended for commercial uses? (3) Will there be any possibility of tainting? And (4) is it a safe gas to recommend?

(1) We know that methyl bromide is a heavy gas and under certain temperatures it will penetrate through grains to a great depth. We should note that grains which have been placed in bins during the summer months and are under normal storage conditions, do not change in temperature more than two or three degrees Fahrenheit. That is to say, grain with a temperature of around 55° to 60° F. when placed in the bin, would retain that temperature throughout the year. Grains which have been placed in a bin during the winter months and which may have been exposed to low temperatures in transit, might register as low as 30° to 35° F., which would be too low for fumigation with methyl bromide. Optimum temperature for the use of methyl bromide is around 65° F., but this gas may be used at slightly lower temperatures with good results.

(2) At the present time, the cost of methyl bromide makes the cost of application rather high. Used at the rate of two pounds per 1000 cubic feet in a bin say 26 feet wide by 100 feet deep, would cost approximately $100 and it might be cheaper to run that bin over the driers.

(3) The question of tainting food products must always be considered. Dr. H. C. Dudley of the United States National Institute of Health, Washington, D.C., has been working for several years on the problem of methyl bromide residues and in connection with this matter he has this to say: "In general fresh fruits and vegetables, dried fruits and whole grains absorb but minor amounts of the fumigant. Milled grains and fatty or oily foods absorb a great amount of methyl bromide." Dr. Dudley's tests were made from grains which had been fumigated with two pounds of methyl bromide per 1000 cu. ft. Thus from a residue standpoint, methyl bromide may be used with safety in fumigating whole grains.

(4) The question of the gas being a safe one to recommend has also been studied. Methyl bromide is now being used for the control of pests both of stored products and of green vegetables, and where it is carefully handled there should be no danger in its use. It must be pointed out, however, that the gas is practically colourless and odourless. This constitutes a real danger where it might get into the basement of a large elevator, and the basement not be properly ventilated. It is always best to use a gas mask where ventilation is poor, and the operator should see that the mask fits properly and that the canister used is suitable for that type of gas. Before entering a fumigated building a Halide light detector should be used to detect the presence of methyl bromide. If the gas is present the flame will turn from a purple to a purplish blue, and if the concentration is fairly heavy, the flame will turn entirely blue. There is also one other point that must be thoroughly understood: before entering the basement of any building, particularly if the basement has been closed for some time, the whole building should be opened up and well aired, since it would be unsafe to wear a gas mask if the oxygen content of the air in that basement were low.

Methyl formate has been used in conjunction with carbon dioxide and sold under the trade name of "Proxate", and later methyl bromide was used with carbon dioxide. The idea of the carbon dioxide was to provide a warning gas.

This feature has been studied by Mr. R. M. Jones, Entomologist, Liquid Carbonic Corporation of Chicago, Illinois. It may be possible then, to incorporate sufficient carbon dioxide to provide the necessary warning just as chloropicrin is used with HCN gas.

NOTES ON THE LABORATORY REARING OF SOME CANADIAN TICKS (Acarina) *

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Many of the projects on ticks at the Dominion Entomological Laboratory at Kamloops are dependent, to a greater or lesser extent, on an accurate knowledge of the bionomics of these pests. This study is necessarily a lengthy one, since there are 3 or more stages of each of the 20 or so species involved, and each stage presents a problem of its own, involving a host, and a period of observation lasting for at least several months. As many ticks are highly resistant to unfavourable conditions and can withstand starvation for long periods, the accumulation of data complete with longevity observations, may involve several years' study. Frequently after a number of seasons have been spent in searching for an engorged fertile female of a certain species in order to establish a laboratory strain, progeny have died before a suitable host could be provided. Since knowledge of the host relationships and host specificity of even the more common species of ticks is still fragmentary, certain information relating to these problems gathered at the Kamloops laboratory may be useful.

One of the most important factors in the rearing of ticks is humidity. Although extremely resistant to insecticides, dips, and starvation, practically all Ixodidae require high atmospheric humidity. Species that can survive for a year or more under optimum conditions may desiccate overnight if subjected to normal room humidity. Ticks should be kept in a cool cellar in open-ended glass tubes over damp soil.

As a rule humidity is adequate while ticks are feeding on animals. Nevertheless it is advisable to keep the hosts in a reasonably humid atmosphere. Although this is particularly true for certain ticks from humid areas, it applies also in the dry Interior of British Columbia, for the early stages in the development of ticks are frequently passed either against the moist skin of the host, or in its damp burrows.

While at Kamloops all longevity tests are carried out in a tick cellar (T. 18° C., H. 100%), it has been determined that the best method for holding ticks beyond their normal life span is to store them at 5°C. in pill boxes in a sealed jar containing damp absorbent cotton. In the case of *Ixodes californicus* Banks, the combined periods of preoviposition and incubation normally require four months at 18°C. or two months at 21°C. but can be prolonged for over two years under these conditions.

During storage ticks must be kept free from condensed moisture, as they drown quite as readily as they desiccate. It is advisable to trim off the cotton plug of each vial, and slide it about a quarter of an inch into the tube, to avoid the possibility of water moving up from tray to tube by capillarity. Identification labels should be placed between plug and vial, for if left in the vial the writing soon becomes obliterated by excrement.

Dermacentor andersoni Stiles, the vec-

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tor of many serious diseases, has been studied more than any other species in North America. The techniques of rearing successfully all stages have been worked out by the Rocky Mountain spotted fever laboratory at Hamilton, Montana, where, for the production of spotted fever vaccine, the ticks are, as described by Kohls (1), literally measured by the litre. This is the least specific of Canadian ticks, and feeds readily on nearly all laboratory animals. Adults are commonly fed on sheep for which a very satisfactory infesting method has been devised at this laboratory. The ticks are placed over a clipped and washed area about the size of the tick cage which is a shallow cup of 20 mesh brass gauze about 1½ inches in diameter, with tape-bound rim. The cage is anchored to the skin by six or more opposing linen threads which are first attached to the wool by clove-hitches, then threaded through the edges of the cage and tied. The ticks are inserted before the final fastenings are made. If placed on the shoulders, these cages cannot be scratched off by the animal, and need only occasional adjustments. Nymphs and larvae, usually fed on rabbits or guinea-pigs, may be allowed to feed anywhere on the host, simply by enclosing both host and ticks overnight in a bag made of unbleached cotton, or may be confined to certain areas by means of a screw top capsule, held to the animal by an adhesive band around the belly (1), or in the case of a rabbit, by enclosing the ticks within the ears by means of adhesive tape. Rabbits' ears may also be bagged by slender sacks which tie around the base of the ear. The bags should be taped together to prevent their being torn off.

D. albipictus (Packard) normally infests deer, cattle and horses, passing all stages on the same host and feeding during the winter months. Flat adults taken from moose, however, have been found to feed readily on sheep and guinea-pigs.

Ixodes californicus Banks, is probably the most delicate of our ticks and is extremely sensitive to desiccation. It has yet to be proved that this is a short-lived tick in nature, but under no circumstances have we been able to keep flat adults alive for more than six weeks under laboratory conditions. Furthermore 100 pairs kept in a cage in their normal Coast habitat during the summer of 1941 were all dead when examined four months later. Adults of the closely related European tick *I. ricinus* have been kept alive from 15 to 27 months by Wheeler (2).

The natural hosts of adults of *I. californicus* are dogs, cats, humans and deer. At the laboratory they can be fed readily on sheep by the cage method mentioned above. They are, however, so dependent upon high humidity, that it is necessary at Kamloops to carry out infestations under a burlap tent, over which water is continually sprayed. The engorging period is about 6½ days. The early stages of this species are hardier than the adults for seeds and nymphs have been kept alive for 17 months. The main host of the early stages in nature appears to be the lizard, *Gerhonotus principis* Baird and Birard. Lizards in captivity can be maintained readily on a diet of mealworms, grasshoppers, cockroaches or crickets. These reptiles make convenient and clean laboratory hosts, although the ticks require three times as long to engorge on them as on mammalian hosts. Both early stages will completely engorge in about 7 days on rabbits and guinea-pigs, but, as pointed out in a previous paper (4) the host may be killed if infested too heavily. *I. californicus* feeds poorly on domestic chicken, and in nature has been taken in abundance on birds as seeds on grouse chicks. Rats and mice, whether domestic or wild, appear to be poor hosts. Although fair numbers of seeds have attached to laboratory rats, the fed ticks were all of a reddish color instead of black. It is presumed that these were of low vitality, as it has been found that very pale *I. texanus* seeds which have engorged on serum only, have

been incapable of moulting to nymphs. *I. californicus* has not been induced to feed on fitches, tortoises, snakes or toads.

I. texanus Banks is as hardy as the preceding species is delicate, and of the strain being maintained at Kamloops, all stages are healthy after having been confined in tubes for over 3 years. The life-cycle of this tick thus may occupy a period of 9 years or even longer. It is resistant to desiccation and feeds readily in all stages on members of the ferret family. In the Interior drybelt of British Columbia, *texanus* is a common parasite of weasels and wild mink. Adults also feed well on dogs and sheep. Fitches have proved to be the best laboratory hosts, though there is a tendency for them to build up a temporary immunity after an infestation (6). No stages have been taken on the red squirrel, which in the drybelt is host to a similar but very specific tick, *I. hearlei* Gregson (3).

Because of the ease with which *texanus* may be reared, and because it is parasitized by *Hunterellus hookeri* How., this tick may prove to be a good intermediate host if that parasite should be cultured for control of *I. californicus*.

Another Drybelt tick, *I. hearlei* Gregson, closely related morphologically to *texanus* has been found only on the red squirrel, *Tamiasciurus hudsonicus* ssp. Attempts to rear specimens on other laboratory animals including flying squirrels, have failed so far. From early observations *hearlei* appears to be a hardy species of tick.

I. cookei var. *rugosus* Bishopp is rare in British Columbia. Our only live specimens were engorged nymphs from a coyote. Several of the resulting adults attached to a guinea-pig, but fed slowly and finally died. Dogs would probably be satisfactory laboratory animals for this tick.

I. dentatus spinipalpis Hadwen and Nuttall, and *I. angustus* Neumann, both Pacific Coast species, are parasites of rabbits and squirrels. They have been taken on the packrat which it is thought will be a suitable laboratory host for at least *spinipalpis*.

I. signatus Birula, is normally found on the cormorant. Though refusing to attach to domestic chicks and ducks, seeds and nymphs fed readily on a domestic goose, the engorging period being approximately 7 days. The ticks were caged over the bird's head by means of a voile hood. All attached overnight. The length of life of seeds and nymphs appears to be only about 6 months.

Haemaphysalis leporis palustris Packard and *H. cinnabarina* Koch, the rabbit and bird ticks, each feed on either of these hosts though best results have been obtained by placing *palustris* on domestic rabbits and *cinnabarina* on captured grouse. *H. cinnabarina* engorges rapidly and drops from its host in about 7 days. It is an autumn tick and since oviposition would not take place until spring it appears to have an exceptionally long preoviposition period. Seeds of *cinnabarina* and *palustris* have been kept alive for 7 months, and nymphs of the latter for 19 months.

Although none of the argasid of "soft ticks" have yet been procured for life-history studies at this laboratory, several species have been recorded in British Columbia. Both *Argas persicus* (Oken) and an *Ornithodoros* tick have been collected by Professor G. J. Spencer, the former from a golden-crowned sparrow, the latter from a bat. Both species feed rapidly except in the larval stage. It has been found that *O. turicata* (Duges), a species occurring in the United States, can be maintained easily on rats. The larvae are placed in an infesting cage on the host for about 3 days, after which the engorged ticks are collected and the cage, debris and host fumigated. The several subsequent stages are best fed at the clipped belly of a rat that is held on its back by means of tape over its legs and neck. The ticks engorge in about 30 minutes and apparently do

not harm the host. Nymphs have been induced also to feed through membranes of skin on vials of warm defibrinated rabbit serum; they moulted successfully. This tick is very resistant to desiccation, and may live for many years under cool damp conditions.

Ornithodoros megnini (Duges), the spinose cattle-ear tick, is a species that has recently been taken in British Columbia by the Kamloops laboratory. It differs from all other ticks in that only the larval and nymphal stages feed. The nymphal engorgement is sufficient to enable the adult to oviposit without feeding. Since both the early stages of this species stay on the host and may feed for over 3 months, it is doubtful if any artificial method of feeding can be used in laboratory rearing.

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Asilidae from Robson, B.C.—Dr. S. W. Bromley has sent the following names of species not included in my list in the last number of the "Proceedings" (No. **38**: 14.) *Laphria ferox* Will.; *Bombomima columbica* Walker; *Andrenosoma fulvicauda varlutea* McAtee; *Cyrtopogon praeceps* Will.; *Eucyrtopogon nebulo* O.S.; *Asilus vescus* Hine. It is possible that the following species were misidentified, and should be removed from my List: *Laphria francisana* Bigot; *Asilus auriannulatus* Hine.—H. R. Foxlee.

Hemichroa crocea (Fourcroy). Larvae of this alder sawfly were taken on *Alnus* sp. at Gleneden, near Salmon Arm, June 26, 1941, y A. M. Gilmour of the Provincial Forest Service. In British Columbia the species was known previously only from the lower Fraser Valley. A life history and illustration of the larva has been published by G. R. Hopping, 1937 (Canadian Ent. **69** (11): 243-249, plate 13).—Hugh B. Leech.

Gyrinus pectoralis Leconte. A distinctive little whirligig water beetle which has been collected at Copper Mountain, B.C. by G. Stace Smith (see 61st. Ann. Rept. Ent. Soc. Ontario, (1930), 1931, p. 88) More recently G. J. Spencer has taken it at Kamloops, 18. VIII. 37; and at Bachelor Swamp, between Pass Lake and Lac du Bois, high on the ranges north of Kamloops, 8.VI.41.—Hugh B. Leech.

X